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THE HUMAN USE OF TELECOMMUNICATION SYSTEMS.(U)
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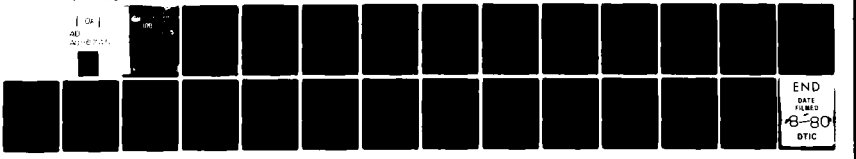

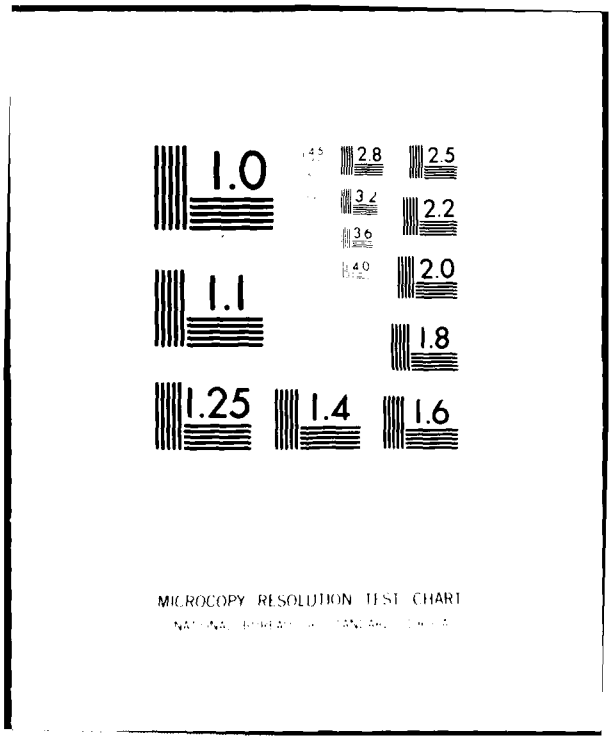
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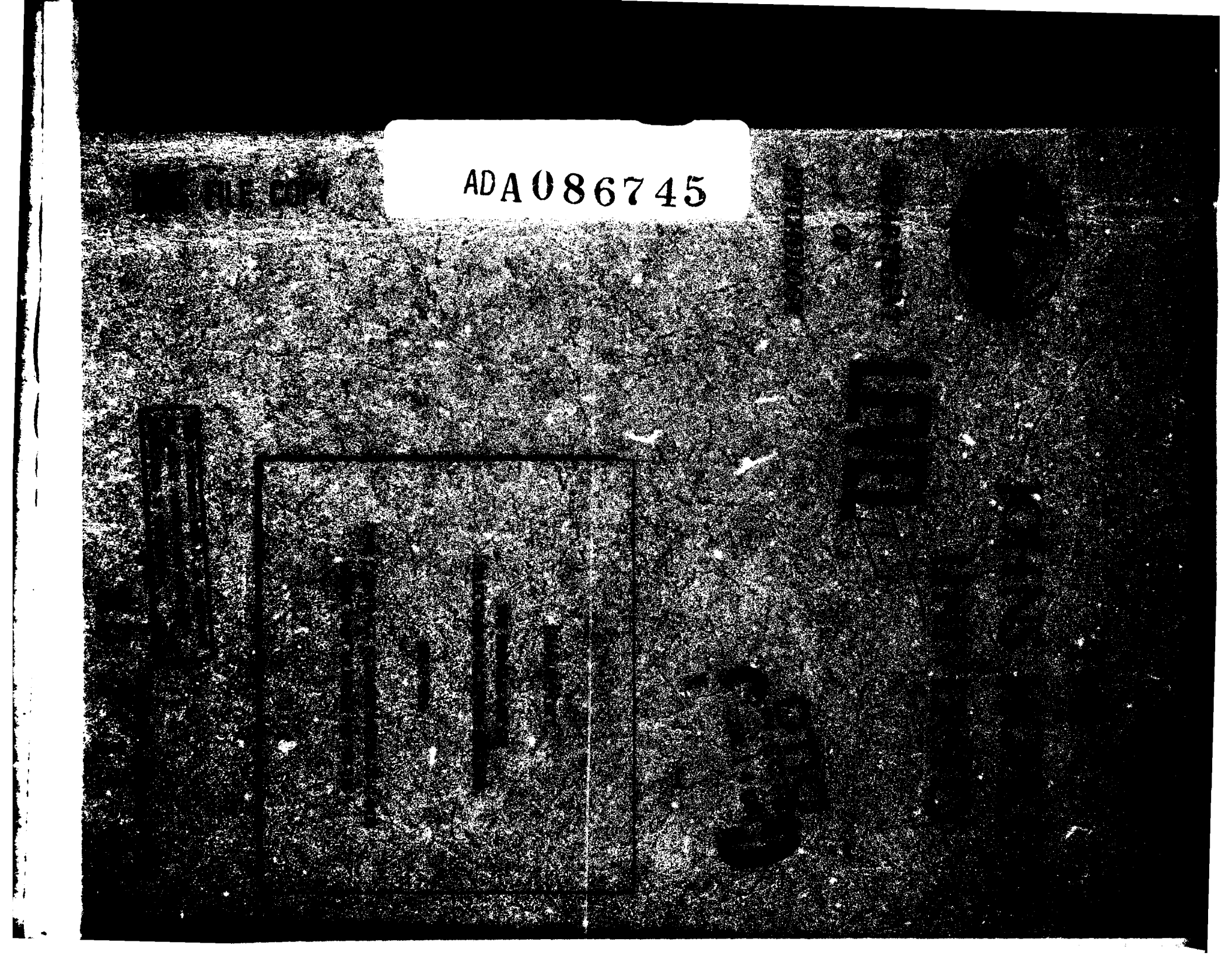

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REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: FINAL REPORT	2. GOVT ACCESSION NO.: AD-A086 745
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): The Human Use of Telecommunication Systems	5. TYPE OF REPORT & PERIOD COVERED: FINAL REPORT - 1 Oct 74 - 30 Jun 80, 10/01/74 - 06/30/80
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Alphonse Chapanis	8. CONTRACT OR GRANT NUMBER(s): N00014-75-C-0131
9. PERFORMING ORGANIZATION NAME AND ADDRESS: Professor Alphonse Chapanis, Department of Psychology, The Johns Hopkins University, Baltimore, Maryland 21218	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: NR 196-135
11. CONTROLLING OFFICE NAME AND ADDRESS: Engineering Psychology Programs, Code 455, Office of Naval Research	12. REPORT DATE: June 80
	13. NUMBER OF PAGES: 14 (12) 24
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Communication	Learning Effects	Telecommunications
Conferences	Meetings	Teleconferencing
Language	Problem-Solving	Terminal configuration
Leadership	Sex	Word usage

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report summarizes a series of studies in a research program dealing with interactive communication, conferencing and teleconferencing. The studies fall into three broad classes: (1) a naturalistic study of real conferences in academic, business, and government settings; (2) several laboratory experiments investigating human and system variables in telecommunications; and (3) studies relating to language and language usage in interactive communication and telecommunication. The principal findings of the studies are summarized and integrated and implications are drawn for the design of telecommunication systems.

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The Human Use of Telecommunication Systems

Alphonse Chapanis

This is the Final Report of research supported by Contract Number N00014-75-C-0131 between the Office of Naval Research and The Johns Hopkins University. Alphonse Chapanis is the principal investigator.

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This contract supported a number of studies dealing generally with interactive communication as it relates to telecommunication. The studies fall into three broad classes: a naturalistic study of conferences, several experiments dealing with human and system variables in telecommunications, and studies relating to language usage in interactive communication and telecommunication. A couple of miscellaneous papers were also prepared under this contract. For details about each of the studies consult the technical reports and publications listed at the end of this report. What follows are only brief summaries of some of the main findings that have come out of the work done on this contract.

The General Orientation of the Research Program

The impact of communications technology on modern society has been described as a communication "explosion" or "revolution." Within only a couple of decades, electronic devices have given us the ability to communicate simultaneously with people scattered throughout the world. This kind of communication has come to be called "teleconferencing." In its most common form, teleconferencing includes all dyadic, or two-way, telephone conversations. However, the term "teleconferencing" is more commonly used to refer to communications involving more than two persons. The interactive nature of communications among conferees distinguishes teleconferencing from such one-way, or non-interactive, forms of communication as radio and television broadcasts.

Genuine teleconferencing occurs among people in offices or homes that have telephone extensions and that involve more than two people at the same time. Of much greater significance, however, are the many businesses and government agencies that conduct weekly, and sometimes daily, centrally-arranged conference telephone calls among people located in various cities throughout the world. Not only do these calls provide speed and convenience in the conduct of regular meetings or in joint decision-making ventures among groups of people who may be physically separated, but they also conserve personnel time and money by substituting for face-to-face meetings.

Teleconferencing, of course, is not limited to the telephone medium. Electronic devices allow groups of physically-separated users to communicate via television, audio, teletypewriter, and telautograph (handwriting) linkages. Although such conference systems are less common than the telephone, they have been used in such diverse conference applications as telemedicine and telebanking. Another, still newer form of group communication called computer teleconferencing provides geographically dispersed persons with immediate printed records of their communications and with facilities that allow messages to be

retrieved en masse or selectively, for example, by date, sender, or topic. Computer teleconferencing also makes conferees independent of time as well as space, since conferees need not be simultaneously in attendance to receive and send messages.

The rapidity of these technological advances in the area of communications has led some people to overestimate their potential. For example, Licklider, Taylor, and Herbert predicted in 1968 that "In a few years, men will be able to communicate more effectively through a machine than face to face." More than a few years have passed since that prediction was made and we will have to wait at least a few more years before we can see the prediction fulfilled. In actuality, the systems that have been the end products of modern technology have not all been success stories. Some, in fact, have been colossal failures, largely due to the way people interact with or respond to these systems. This state of affairs has led some people to conclude that advances in modern communication technology have surpassed our understanding of their human consequences and of the ways that new systems need to be designed to match human needs, capacities, and limitations.

Considerations such as these provided the rationale for the Hopkins program. The goals of the program were to provide us with a better understanding of

- how people naturally communicate with each other when they are required to solve problems of various kinds,
- how interactive communication is affected by the machine devices and systems through which people converse, and
- what significant system and human variables affect interactive communication.

A Study of Meeting and Conference Behavior

For the most part teleconferencing research and development has been technology driven. Primary concern has been directed toward using sophisticated technological devices such as video telephones, closed-circuit television, and interactive computers to overcome the physical separation of teleconferees by the more-or-less faithful replication of important aspects of face-to-face communication. That is, most systems mimic or try to mimic certain features of face-to-face meetings. From this perspective, the primary question seems to have been, "Can people adapt to this or that new communication mode?"

The study by Brecht (1979) took the reverse point of view. He asked "How do people normally carry on conferences?" "For what purposes do people have conferences?" And "What facilities would people need to carry on conferences if they were separated from each other?"

In a sense, this study should have been the first in our program, but for several practical reasons it could not be done in that sequence.

The primary purpose of Brecht's study was to collect detailed, descriptive data about meetings in three different environments: academe, business, and government. Altogether 48 meetings, 16 of each kind were studied. Four data collection instruments were used:

1. A "Meeting as a whole" record sheet for recording general descriptive information about the meeting, for example, the time and location of the meeting; the number, role, and status of participants; and the configuration of the meeting room.

2. A behavioral coding scheme for recording participant interactions and selected meeting events.

3. A "Supplemental communication aid" information card for recording the use of audio-visual aids.

4. A participant questionnaire for eliciting non-observable information about the meeting.

This study traded depth for breadth of coverage. A small number of meetings was studied exhaustively to yield an enormous amount of information. The merits of such a trade-off can, of course, be debated. We feel that our decision was justified by the volume and quality of the information obtained.

The data were analyzed by a variety of sophisticated statistical methods, among them, multivariate analysis of variance, factor analysis, and cluster analysis. Only a few of the many significant findings are discussed here with their implications for teleconferencing.

Differences Among Groups

An assumption that seems to underlie the design of most teleconferencing systems is that facilities should match specific kinds of meetings and meeting objectives. The findings of this study suggest that that assumption may be incorrect. One of the most interesting outcomes of this study is that, despite extensive statistical analyses, we could find only very few statistically significant differences among the academic, business, and government meetings. For purposes of teleconferencing design the only important measurable difference among the three kinds of meetings concerned the kind of supplemental aids used. Blackboards were used only in academic meetings; films, slides, and vugraphs only in business and government meetings. Charts were more frequently used in business meetings; non-conventional and other aids

were more frequently used in government meetings.

Aside from those quantifiable differences, the only other differences observed among the three kinds of meetings are based on impressions of the observer who participated in all the meetings. First, the level of participant sophistication seemed to differ between business and government meetings. Conferees at business meetings tended to be quite familiar with the meeting process, they met regularly, they usually knew one another, and they knew what they individually had to contribute to the purpose of the meeting. In contrast, government meetings often involved members of the general public who did not attend regularly and who were not knowledgeable about how the meeting functioned or what their role in the meeting should be.

A second observation was that business meetings tended to be information self-sufficient while government meetings were more dependent on outside sources of information. In government meetings experts or staff members familiar with a particular subject, that is, people who were not normally members of the group, were often called on to give a special report that provided information needed for the conferees to act. In 19 percent of meetings information not immediately available was specifically requested and some action was taken to get it. When that happened, numerous requests, on the order of a half a dozen, were frequently made in the same meeting. In response to such requests, a participant often left the room to get the information, telephoned from the room to someone outside the room to get the information, or promised to provide the information at a later time. Occasionally, no action was taken and participants proceeded without the requested information. These findings seem to indicate that participants, especially those in government meetings, do not prepare themselves adequately for some meetings or that a substantial number of such meetings generate unanticipated information needs.

It was not clear from the study whether these deficiencies in information could have been anticipated and so avoided by more thorough participant preparation or whether they were spontaneously generated during the course of the meeting. In either case, it seems important to recognize the probability that additional, outside information will be required at some meetings and that provision for obtaining that information, for example, conference room telephones, support staff, or computerized information retrieval systems, should be provided for participant use. These information support provisions may be particularly important in teleconferenced meetings due to the time constraints under which such conferences are held.

A third observation was that government meetings and some academic meetings seemed always to be hurried and rushed. Participants in these meetings acted as though they regarded meetings as an obligation that took them away from other things that were more important. They

often cited busy schedules as the reason for arriving late or leaving early, both of which were frequent occurrences in these meetings. Participants at business meetings, on the other hand, seemed to regard the meeting and time required to attend it as a legitimate part of their job. There was far less pressure in business meetings to "get it over with so that we can get back to our work."

The implication of these findings is that it will probably be more difficult to do a good job of devising satisfactory teleconferencing systems for government meetings than for academic and business meetings. Among other things, systems intended for government use will have to accommodate a much wider range and lower level of participant capabilities and sophistication and should be simpler to use.

Communication Activities

It should not be much of a surprise to learn that communication was the single most important activity in all meetings. What might be surprising is the amount of communication that went on and the form that it took. About 93 percent of total meeting time was devoted to communication interactions and that proportion was almost identical for academic, business, and government meetings. Another surprising finding was that 97 percent of all communications were entirely oral. Communications that were only written, physical, or gestural accounted for only one or two percent of all communication interactions. Many teleconference systems seem to have been designed on the assumption that it is necessary for all participants to see each other. Our findings suggest that this may be a mistaken assumption. It may also account for the relatively good success that has been achieved with some purely voice teleconferencing systems and for the small differences we have observed in our laboratory studies between face-to-face meetings and those conducted by voice only (See Pages 9-10).

Starting Times

Meetings tended to be scheduled on the hour and the half-hour and most meetings were scheduled for either mid-morning, 9:30 A.M., or mid afternoon, 2:00 P.M. or 3:00 P.M. These preferences for meeting times suggest that if meetings were to be teleconferenced, problems could arise if a single telecommunication studio or facilities had to be shared among several groups. Advance scheduling would be crucial to avoid conflicts and it is possible that many meetings might have to be scheduled at less desirable or less convenient times to accommodate all system users, even when all conferees are in the same time zone. When teleconferences are held among conferees in different time zones, it may be impossible to schedule meeting times that are convenient for all participants, unless computer teleconferencing is used.

Delays in Starting Times

Although all scheduled meetings were planned in advance and scheduled to start at a definite time, only one actually did. When

meetings were delayed, the delays varied widely--from as little as one minute to nearly an hour and a half. The median delay for the meetings that were delayed was seven minutes. Because most teleconferencing systems represent a great capital investment, idle or unused time is expensive. In addition, the failure of most meetings to start on time could cause serious problems when meetings are to be teleconferenced. Most teleconferencing systems are used by several different departments within a single organization or are shared among several different organizations. As a result, the system is available only on request and a limited amount of telecommmunication transmission time is allocated to each group for a specified period of time. Only during this time is it possible to interact with participants in other locations. Any delay in starting at the scheduled time is a waste of expensive communication time.

To make matters worse, teleconferenced meetings of this type must stop at the end of the allotted time regardless of whether the business of the meeting has been concluded in order that others may use the system. Unlike face-to-face meetings, teleconferences conducted under these constraints cannot run over to compensate for an initial delay.

These differences between the relatively free manner in which face-to-face meetings typically seem to be conducted and the rigid time constraints imposed by some teleconferencing systems presents designers with a dilemma--should teleconferencing systems be made more flexible, or should conferees adapt to the constraints of the system? Although the former seems preferable from a human standpoint, it is also a much more expensive solution.

Meeting Purposes

A great deal of research has been done to find out which of several alternative modes of teleconferencing, for example, audio, closed-circuit television, or computer conferencing, is most appropriate for meetings with particular objectives or purposes. Our results suggest that this common assumption is faulty. Not a single one of the 48 meetings was conducted for a single purpose. The modal number of purposes served by meetings was nine, and four meetings were judged to have served as many as 12 different purposes. It appears that teleconferencing researchers and designers should proceed on the more reasonable assumption that all meetings are multi-purpose meetings.

Supplemental Communication Aids

A genuine surprise to us was to find out how many different kinds of communication aids were used in our meetings. Supplemental communication aids were used in 88 percent of meetings and, on the average, six aids were used per meeting. In addition to such conventional communication aids as films, audio recordings, and vu-graphs, participants at our meetings used 19 different additional kinds of communication aids,

among them maps, membership directories, voter registration cards, pieces of equipment, samples of carpet, reservation forms, calendars, newspaper clippings, tickets to civic events, computer printouts, and wallet cards of emergency procedures. If they are to be completely successful, teleconferencing systems should provide facilities to handle all these diverse kinds of materials.

Two percent of all aids required from participants some action or response, such as signatures on authorization forms. This requirement, although infrequent, places demands on a teleconferencing system that are difficult to meet.

Movement

Another surprise to us was the overwhelming tendency we observed for participants to get up and move around during meetings to change seats, to converse with participants in another part of the room, to distribute handouts, or to leave the meeting room. Participants moved around in 44 (92%) of the meetings and in those 44 meetings there was an average of 13 changes per meeting. In one meeting there were 89 changes! A participant in another meeting moved a total of 26 times. A participant in still another meeting never sat down; instead he stood or wandered around during the entire meeting. Yet sitting passively is exactly what is required of conferees in most teleconferencing systems. Once again, characteristic human behavior in face-to-face meetings appears to conflict with teleconferencing system requirements.

Coffee and Luncheon Breaks

Coffee and luncheon breaks were unexpectedly frequent in face-to-face meetings. Several meetings recessed at mid-morning for a brief coffee break before the resumption of business. In addition, several meetings that had begun in the morning, recessed for lunch, and then continued after lunch. Sometimes lunch was catered in the meeting room so that business was conducted during the lunch period.

The frequency of breaks in face-to-face meetings raises an interesting question of if, and if so how, these services might be coordinated and provided in teleconferences when participants are geographically separated. The complications imposed by differing time zones, separate food preparation facilities, and even regional or national food preferences and tastes stress the importance of preplanning and organization when meetings are to be teleconferenced. If these amenities are to be observed, then conferees will have to adjust to still more constraints on these customary conference activities.

Overall Implications

To sum up, this study of face-to-face meetings and conferences has been productive in that it has yielded a great deal of information

about what actually goes on in meetings and how they are conducted. In some cases, the data of the study allow us to throw serious doubts on assumptions that have been used in the design of teleconferencing systems. At the same time the findings have identified heretofore unrecognized meeting activities and characteristics that represent special requirements that must be met in the design of teleconferencing systems if they are to provide the kind of flexibility currently offered by face-to-face meetings. Even so, it appears that even the best of all possible teleconferencing systems will impose constraints, and perhaps serious constraints, on the normal free and flexible human behavior that occurs in regular face-to-face meetings and conferences. In the face of those constraints what seems to be required is the development of a set of teleconferencing procedures and rules of conduct for participants in teleconferences.

The Laboratory Studies

The laboratory studies conducted as part of this research program all used carefully-controlled, multi-variate experimental designs, with several dependent measures obtained in each study. In every case, analysis of variance, or multivariate analysis of variance statistical techniques were used to analyze the data. A large number of real-world, meaningful problems of diverse sorts were used. The studies were designed to measure the effects of two principal kinds of variables--psychological and system variables--on teleconferencing performance. Although the variables are listed below individually, I stress that the experimental designs were all multi-variate designs permitting the examination of interactions among many of these variables.

Psychological Variables

The principal psychological variables studied were:

1. Sex of the conferees (Ford, TR 1977;* Ford, Chapanis, & Weeks, 1979; Michaelis, TR 1979; Weeks, TR 1980; Weeks, 1980).

2. The number of conferees (Krueger, TR 1977; Krueger & Chapanis, 1980).

3. Restrictions on word usage versus no restrictions (Ford, TR 1977; Ford, Chapanis, & Weeks, 1979; Kelly, TR 1975; Kelly & Chapanis, 1977; Michaelis, TR 1979).

4. Whether conferees are introduced before a conference begins or whether they begin a conference anonymously (Michaelis, TR 1979).

Note: *Years preceded by the letters TR refer to Technical Reports; years without such letters refer to regular journal publications.

5. Having, or not having, a designated leader or person in charge of the conference (Pagerey, TR 1980).

6. Kind of task or problem (Ford, TR 1977; Ford, Chapanis, & Weeks, 1979; Kelly, TR 1975; Kelly & Chapanis, 1977; Krueger, TR 1977; Krueger & Chapanis, 1980; Pagerey, TR 1980; Weeks & Chapanis, TR 1975; Weeks & Chapanis, 1976).

7. Learning effects over successive days of test (Kelly, TR 1975; Kelly & Chapanis, 1977; Krueger, TR 1977; Krueger & Chapanis, 1980; Pagerey, TR 1980).

System Variables

The principal system variables studied were:

1. Modes of communication, that is, the communication channels provided conferees (Ford, TR 1977; Ford, Chapanis & Weeks, 1979; Krueger, TR 1977; Krueger & Chapanis, 1980; Weeks, TR 1980; Weeks, 1980; Weeks & Chapanis, TR 1975; Weeks & Chapanis, 1976).

2. Terminal configuration (Weeks, TR 1980; Weeks, 1980).

3. Switching arrangements (Pagerey, TR 1980).

Findings

These laboratory studies produced a great many findings, some of which are summarized in Chapanis (TR 1976). There is always a danger of oversimplification in summarizing the outcomes of a research program as extensive as this one has been. The individual studies have been rich in findings and the full extent of those findings can be appreciated only by reading the original reports. What follows is a brief integrating overview of some of the major conclusions that have emerged from them.

1. Mode of communication. The variable that had the largest effect on communication was undoubtedly mode of communication, that is, the electronic communication channels provided conferees. In general, problems were solved much faster, or agreements were reached much more quickly, when conferees were able to talk to one another than when they were not. In effect, this means that face-to-face, audio-visual, and voice-only modes of communication always resulted in faster solutions than did the so-called hard-copy modes of communication, that is, teletypewriting or telautography. Although the voice modes of communication resulted in faster problem solutions, they were also characterized by a much greater verbal output, no matter how that verbal output is measured, for example, number of messages, number of words, or communication rate. Finally, voice-only modes of communication are not

substantially different from face-to-face communication in terms of solution time or the amount of verbal output. In short, when conferees can talk to each other, being able to see one another does not appear to contribute very much to communication effectiveness.

Since these findings are substantiated in every one of the experiments in which these variables were tested, we regard this as a strong conclusion.

2. Number of conferees. Although it is difficult to compare variables across experiments and to place them precisely along a scale of importance, the number of conferees may well be the second variable of importance among all those tested. An increase in group size resulted in an increase in every group measure of communication. That is, the larger groups used more messages, more words, communicated faster, and exhibited greater relative variability among the numbers of messages generated by the individuals within groups. Note, however, that this variable was tested in only one experiment and only 2, 3, and 4 conferees were tested.

3. Problem or task. The kind of problem or task that subjects worked with also had a marked effect on performance. That finding is not particularly important in itself because it is easy to devise problems or tasks that will produce different behaviors. Much more important is that interactions between problems and communication modes were generally small or non existent. In short, we could find no compelling evidence that different modes of communication are substantially more or less effective for some kinds of problems than for others. To be sure, our studies have not exhausted the full spectrum of important human tasks, but our problems were deliberately devised to sample a wide range of human skills. These essential conclusions are supported by every one of the studies in which problems were systematically varied.

4. Restrictions on word usage. Restrictions in word usage were tested in two different ways: (a) by allowing subjects to use only restricted sets of words chosen in advance by the experimenter (Kelly, TR 1975; Kelly & Chapanis, 1977), or (b) motivating the subjects to restrict their own vocabularies (Ford, TR 1977; Ford, Chapanis, & Weeks, 1979; Michaelis, TR 1979). The main conclusion to emerge from these studies is that people can communicate effectively with far fewer words than they ordinarily use. In general, restricting one's use of words does not result in longer times to solve problems.

5. Terminal configurations. Two terminal configurations were tested in one experiment: individual and shared terminals. In the individual configuration, four people were assigned to separate rooms and each person had his own communication terminal: teletypewriter,

voice, or closed-circuit television. In the shared condition, two subjects were assigned to one room, and two others to another room. Each pair of subjects shared a communication terminal connecting the two rooms. Terminal configuration had a significant effect on verbal productivity: conferees in the shared configuration generated nearly twice as many messages as those in the individual condition. Times required to solve a problem were not, however, different for the two configurations.

6. Switching arrangements. One experiment tested two communication systems which either did or did not have centrally controlled switching. Conferees in the system with centrally-controlled switching took longer to solve problems than did those in the open system. Although the same number of words was generated in both conditions, subjects in the two conditions "packaged" their messages differently. Subjects who used the system with centrally-controlled switching used fewer but longer messages than did those in the system with no switching.

7. Practice effects. In three experiments subjects were tested on either three (Kelly, TR 1975; Kelly & Chapanis, 1977), or four successive days (Krueger, TR 1977; Krueger & Chapanis, 1980; Pagerey, TR 1980). Although some changes in performance were found in some of the experiments, notably, a decrease in the number of words used on successive days, the most striking finding is how small these changes have been. Practice effects in these communication tasks appear not to be very great. These findings should be accepted with some caution because subjects were at most tested on only four successive days. Nonetheless, the impression that comes through is that these communication skills are so thoroughly practiced and familiar that not much additional learning can be expected.

8. Sex of the conferees. Some slight differences in performance between the two sexes were observed in one study (Michaelis, TR 1979), but taken together our studies suggest that there are no important differences between men and women that need to be taken into consideration in the design of communication systems.

9. Leadership. In one experiment, leaders were either appointed or allowed to emerge in four-person conference groups tested over a period of four days (Pagerey, TR 1980). The results suggest that leadership was a much less important variable than others that were tested in the same study.

10. Anonymity. In one experiment subjects either were, or were not, introduced to each other before the experiment began. There were no statistically-significant differences in performance attributable to the main effect of this variable or to the interaction of anonymity with any other variable.

Overall Conclusions

These laboratory studies have examined a number of psychological and system variables that are, or might be, important for the design of communication systems. Some variables have turned out to be very important, others less so. The general impression that seems to emerge is that system variables are more important than psychological variables in the design of telecommunication systems.

Language Variables in Communication

Three studies (Ford, TR 1977; Ford, Chapanis, & Weeks, 1979; Kelly TR 1975; Kelly & Chapanis, 1977; Stoll, Hoecker, Krueger, & Chapanis, (TR 1975, 1976) were concerned with certain language factors in communication.

The Structure of Language in Various Modes of Communication

The study by Stoll et al. (TR 1975, 1976) analyzed the verbal output of pairs of subjects who communicated through four different modes of communication to solve problems cooperatively. Each word of the protocols were assigned to one of six linguistic classes based on Fries's analysis of the structure of English. Although the results show some statistically-significant shifts in the relative proportions of the different classes of words as a function of mode of communication, the more striking finding is how small the shifts are. The prevailing impression is more one of similarity than differences among the kinds of words used in the several modes of communication.

Why Are Oral Modes of Communication so Wordy?

Subjects using oral modes of communication generate far more verbiage than do subjects using handwritten or typewritten modes to solve the same problems. One study (Ford, TR 1977; Ford, Chapanis & Weeks, 1979) tested two alternative hypotheses to account for this disparity: (1) written modes produce a hard copy of interchanges, thereby compensating for the limitations of short-term memory and reducing the need to repeat information, and (2) talking is so easy that there is no incentive to be concise in oral modes. In this experiment, two-person teams solved problems either by voice or by teletypewriter. Half the teams were given a monetary incentive to use as few words as possible. No such request was made of the control teams. Subjects in the brevity condition, regardless of the communication mode, greatly reduced verbiage with no increase in time or decrease in accuracy. Moreover, subjects in the brevity-voice condition used even fewer words than did subjects in the control-teletypewriter condition. These results, then, lend weight to the second hypothesis.

The Use of Restricted Vocabularies

One study (Kelly, TR 1975; Kelly & Chapanis, 1977) was designed to find out how well subjects could solve real-world problems if they

were restricted to vocabularies of 300 and 500 selected words. The main finding of the experiment was that subjects who worked with the restricted vocabularies interacted and solved problems as successfully as their counterparts who worked with no vocabulary restrictions. These results indicate that, at least for the kinds of problems tested, it is possible to develop vocabularies of limited size that can be used effectively in man-computer communication.

Miscellaneous Studies

Two miscellaneous studies were also written on this contract. They are: Chapanis (TR 1976, 1976) and Chapanis and Williams (1976).

Technical Reports Issued Under this Contract

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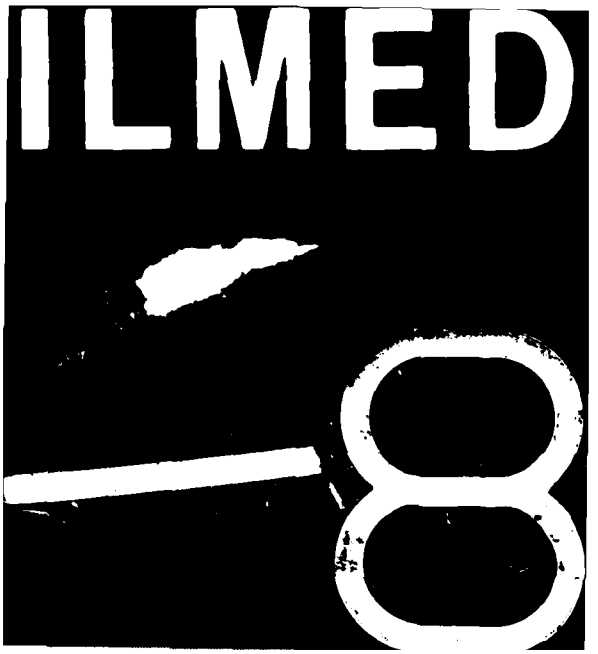
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